Corrosion Control and Cathodic Protection for Water Systems

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by
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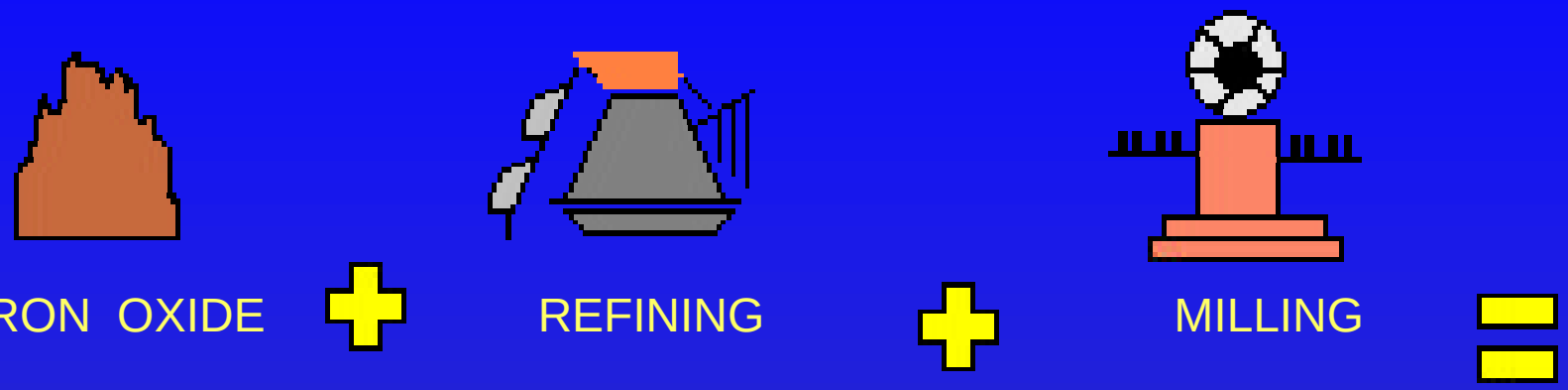
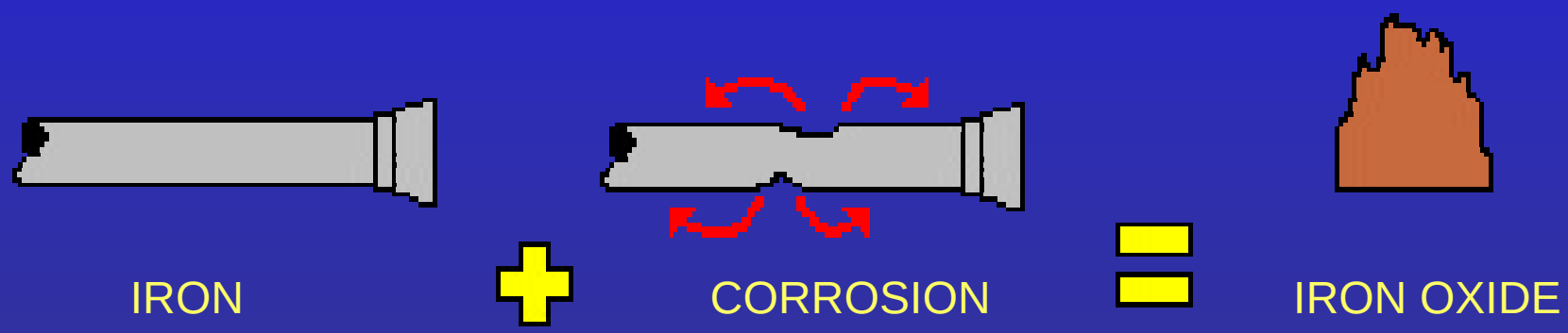
ECONOMICS AND CORROSION CONTROL

Corrosion Control is typically:

- Less than 10% of the Replacement Cost
- 1%-3% of the Cost of a New Structure

Corrosion - A Natural Process





PRACTICAL GALVANIC SERIES

Material	Potential*
Pure Magnesium	-1.75
Magnesium Alloy	-1.60
Zinc	-1.10
Aluminum Alloy	-1.00
Cadmium	-0.80
Mild Steel (New)	-0.70
Mild Steel (Old)	-0.50
Cast Iron	-0.50
Stainless Steel	-0.50 to + 0.10
Copper, Brass, Bronze	-0.20
Titanium	-0.20
Gold	+0.20
Carbon, Graphite, Coke	+0.30

* Potentials With Respect to Saturated Cu-$CuSO_4$ Electrode

Prerequisites for Corrosion

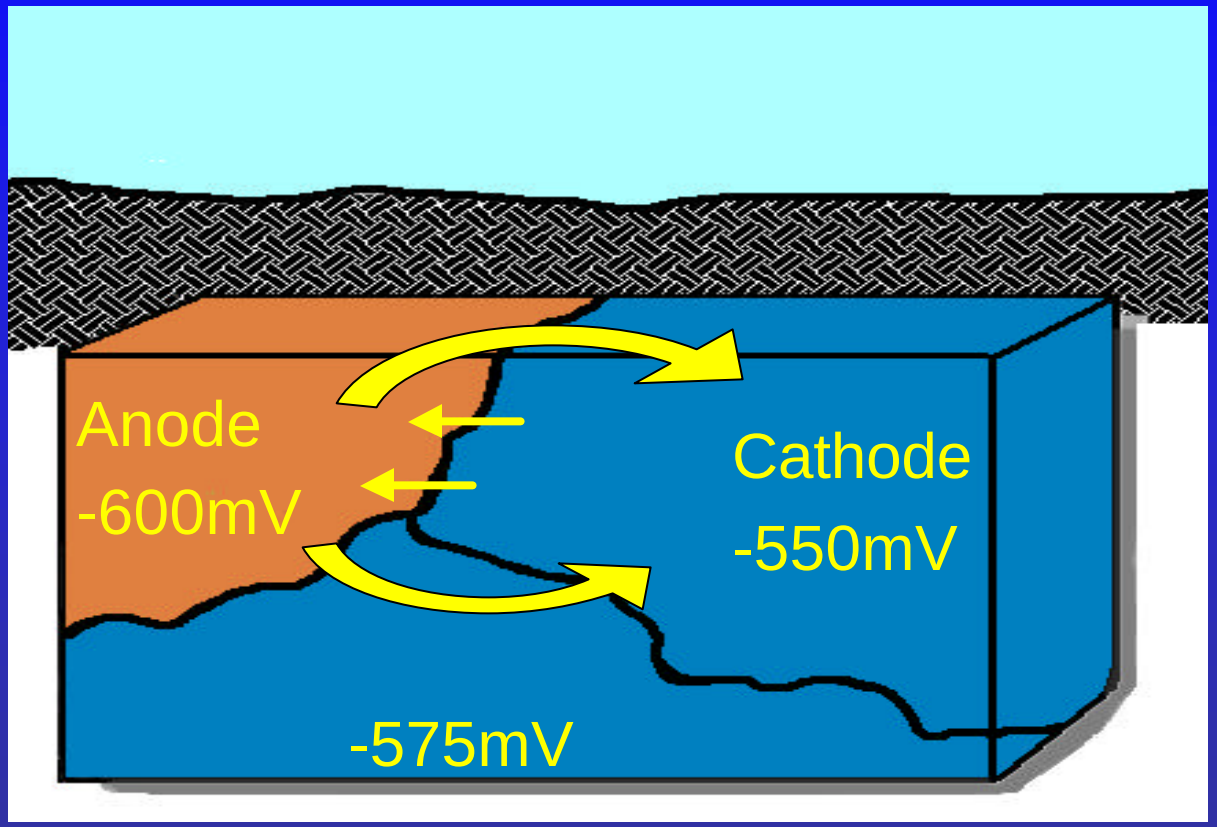
- Anode
- Cathode
- Electrical Connection Between Anode and Cathode
- Electrolyte

1) ANODE

2) CATHODE

3) ELECTROLYTE

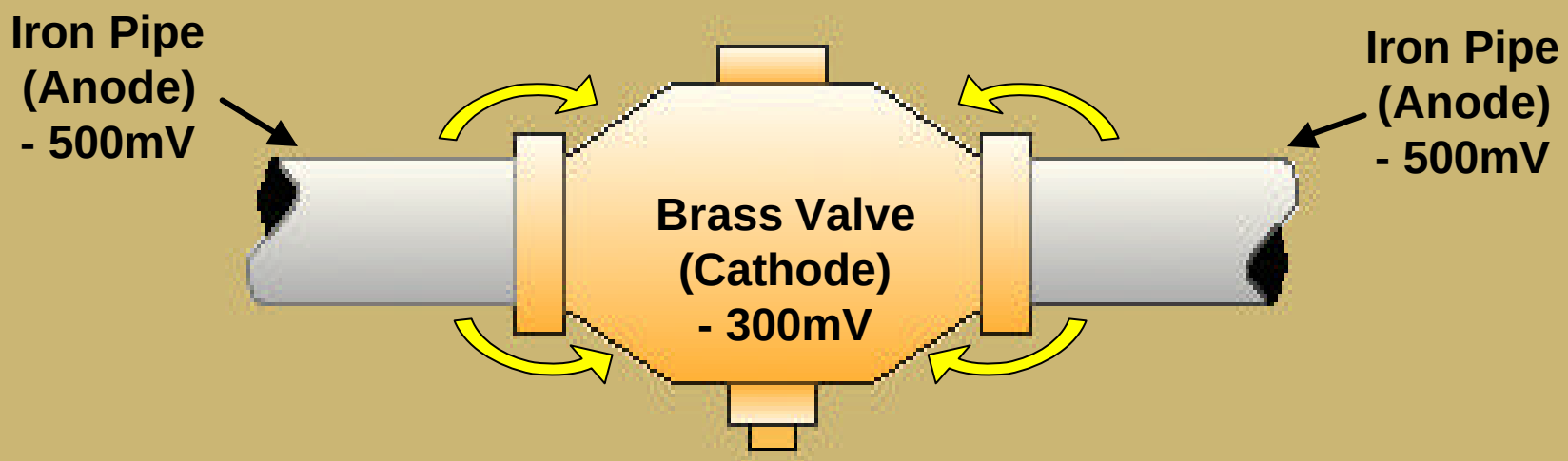
4) ELECTRICAL CONNECTION



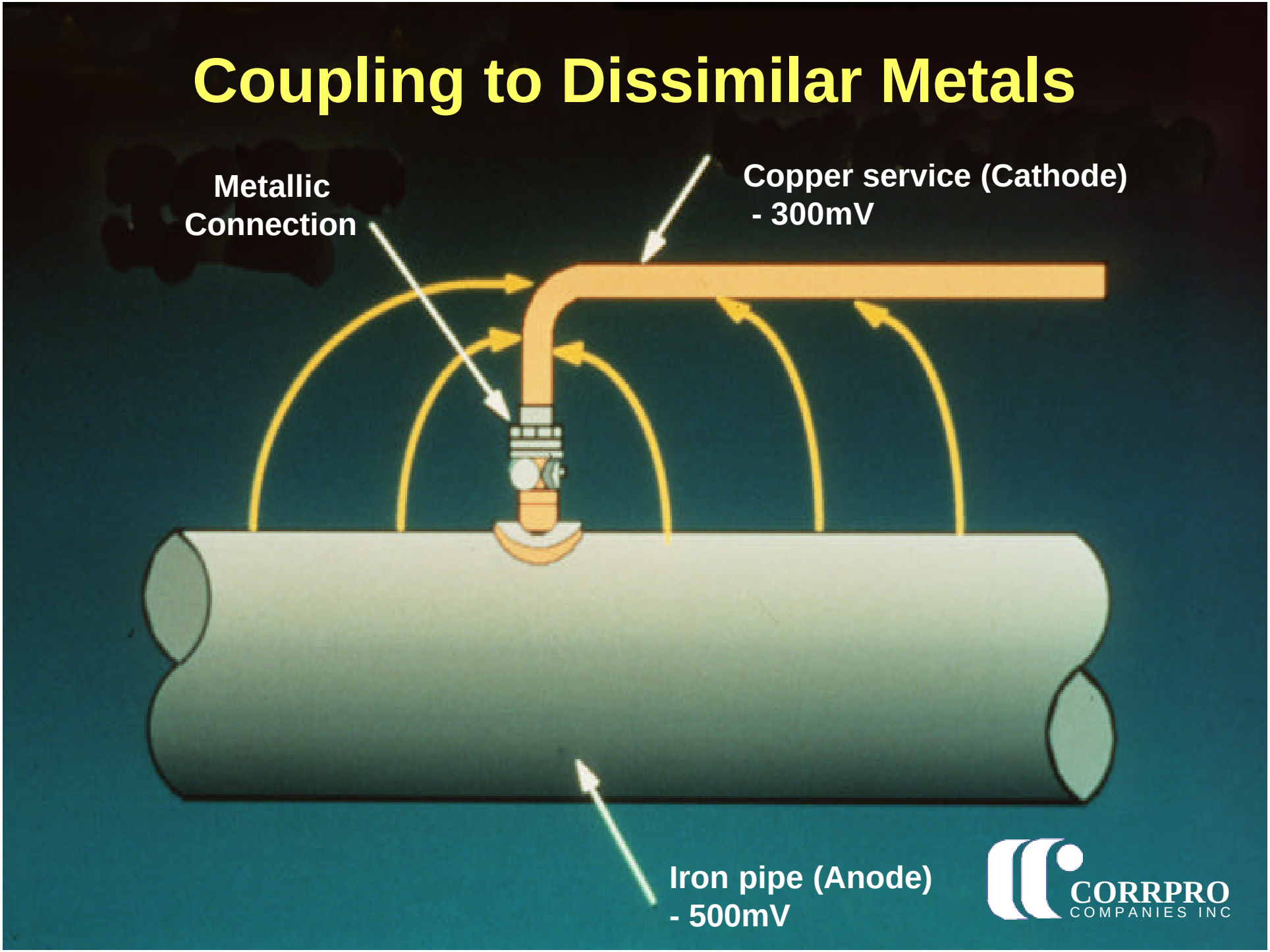
Underground Structures

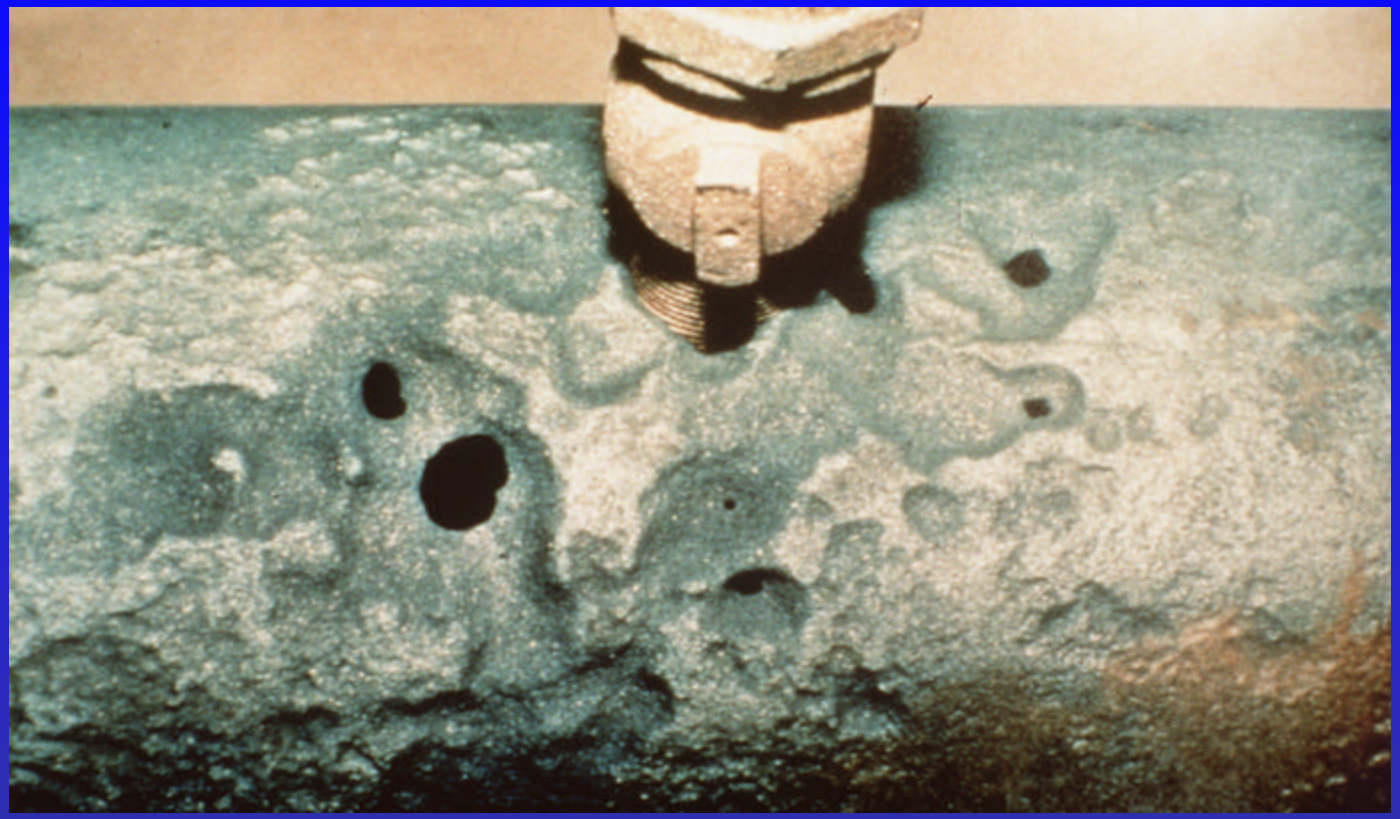
- Causes of Corrosion
  - Dissimilar Metals
  - Non-Homogeneous Soil
  - Differential Aeration
  - Microbiological Attack

Coupling to Dissimilar Metals



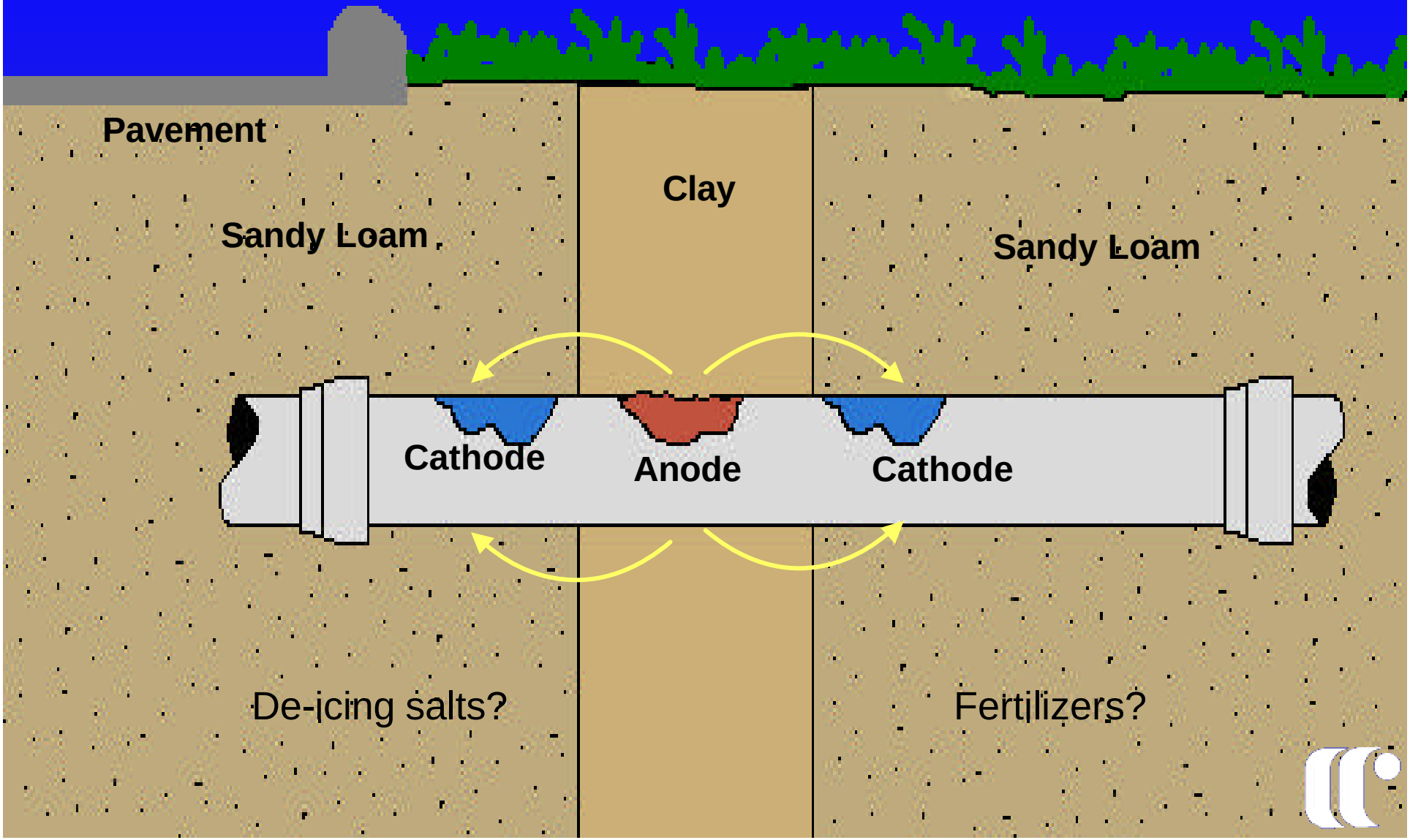
Coupling to Dissimilar Metals



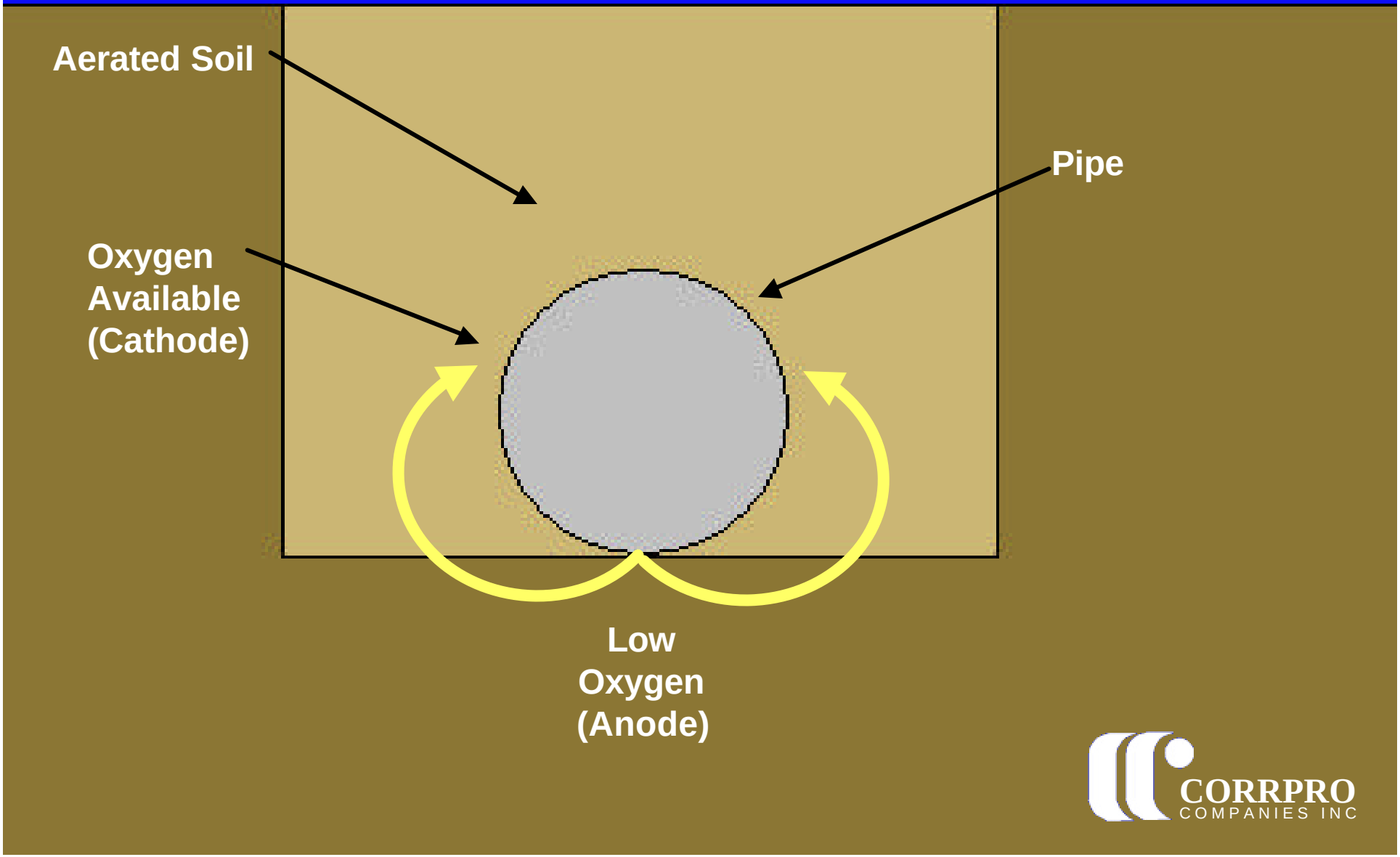


Corrosion of iron when coupled to copper service line.

Dissimilar Soils



Corrosion Caused by Differential Aeration



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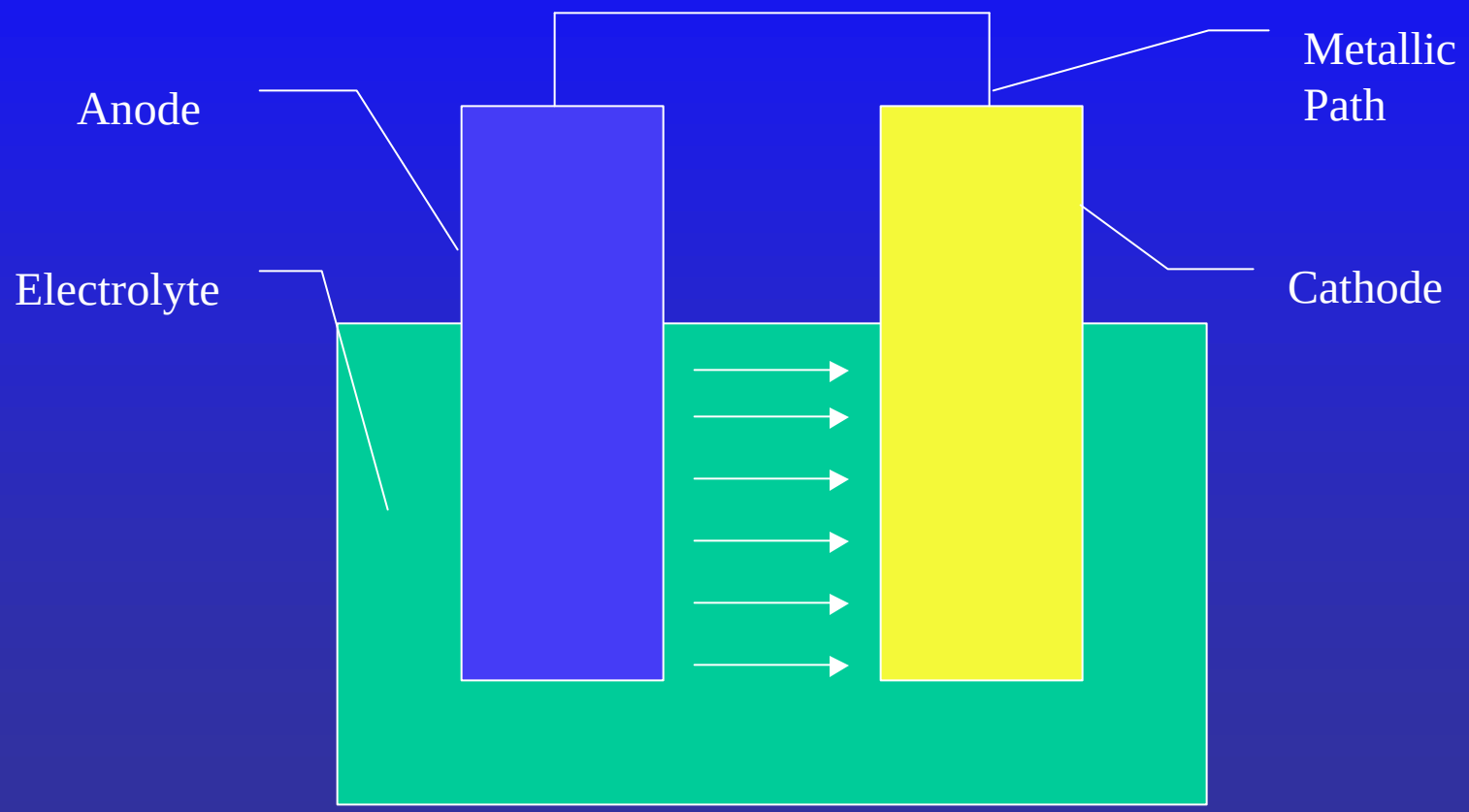
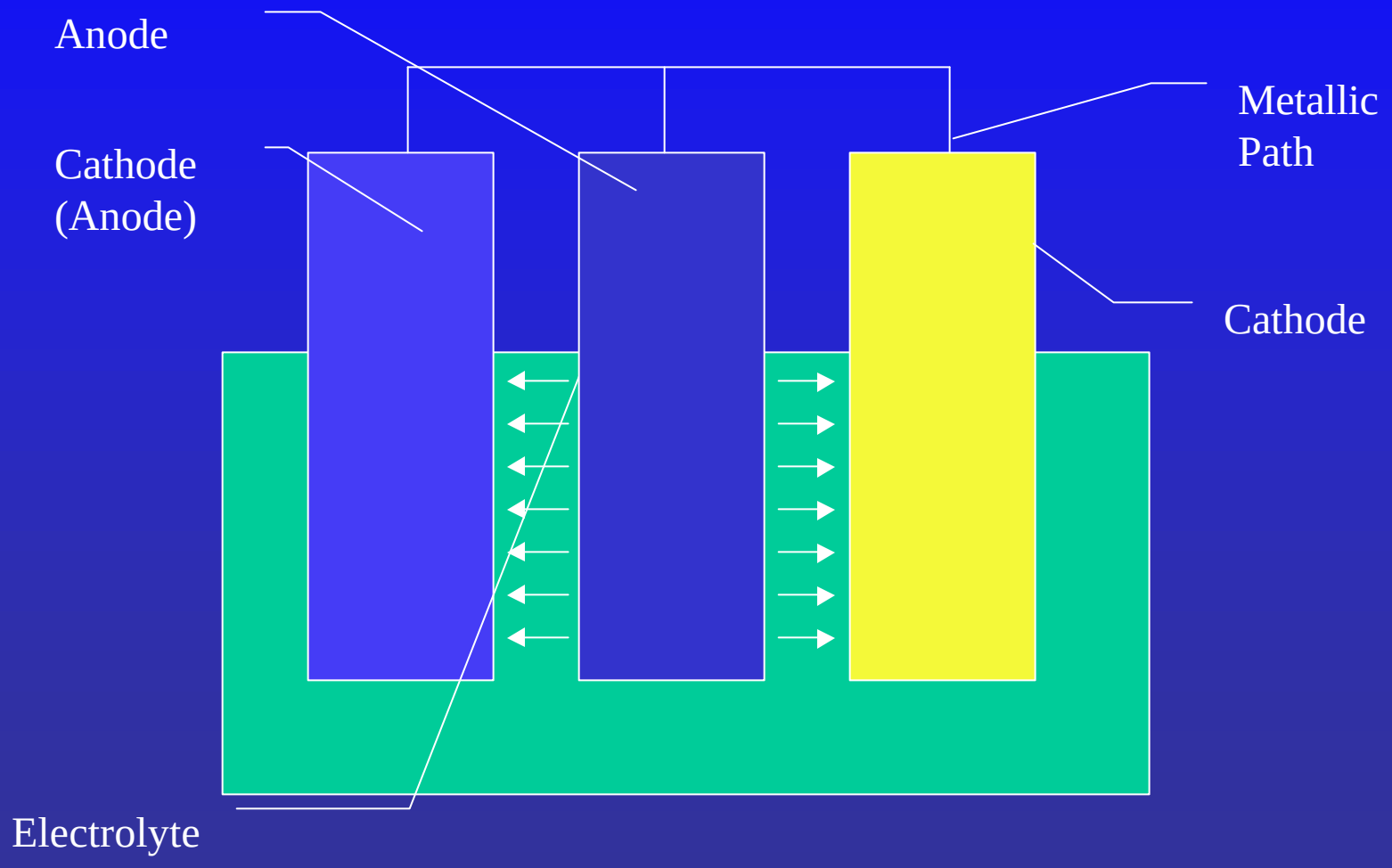
Corrosion Cell



How Cathodic Protection Works

- Corrosion occurs where current discharges from metal to electrolyte
- The objective of cathodic protection is to force the entire surface to be cathodic to the environment

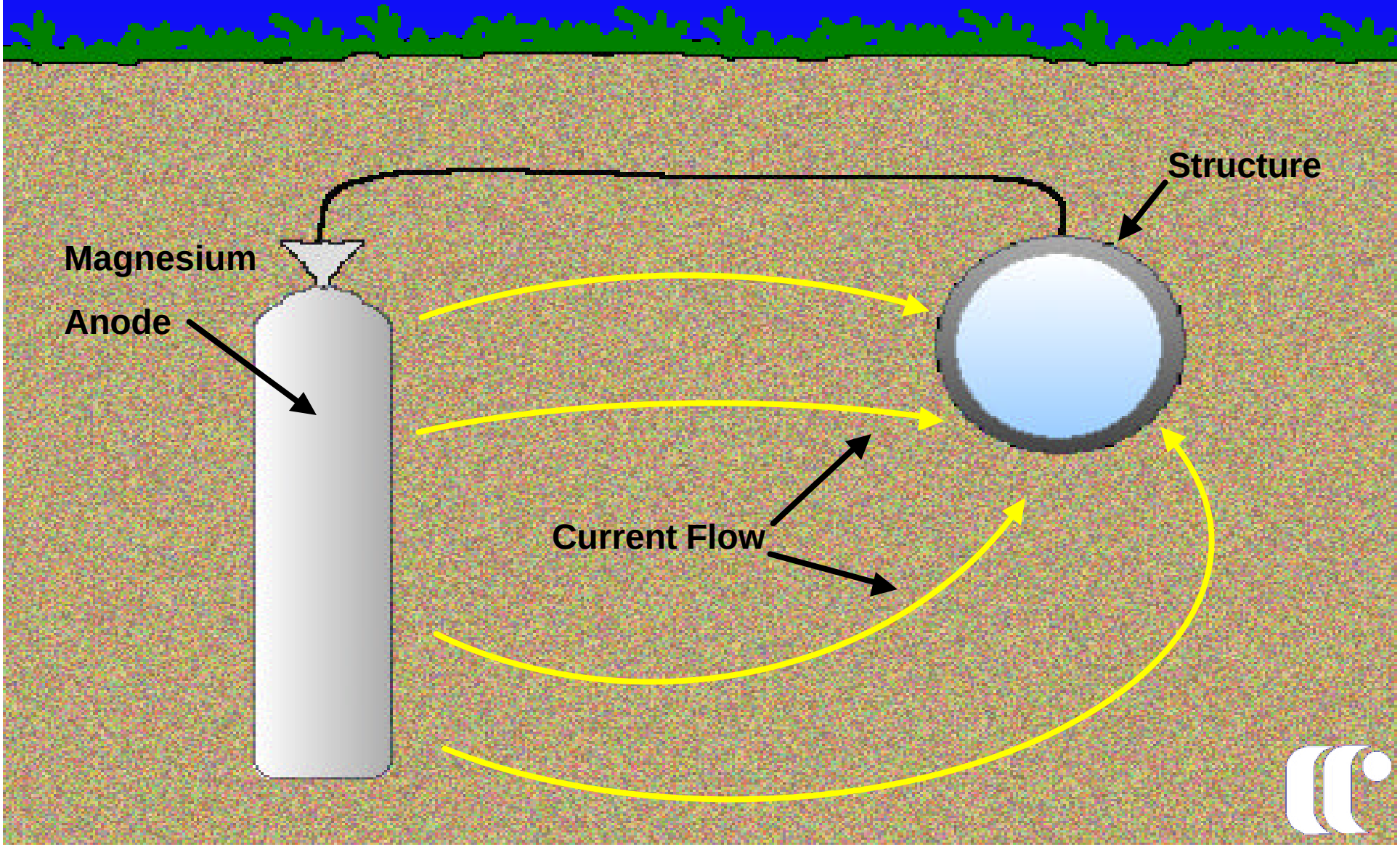
Cathodic Protection



Galvanic Anode Cathodic Protection

- Current is obtained from a metal of a higher energy level

Galvanic Cathodic Protection



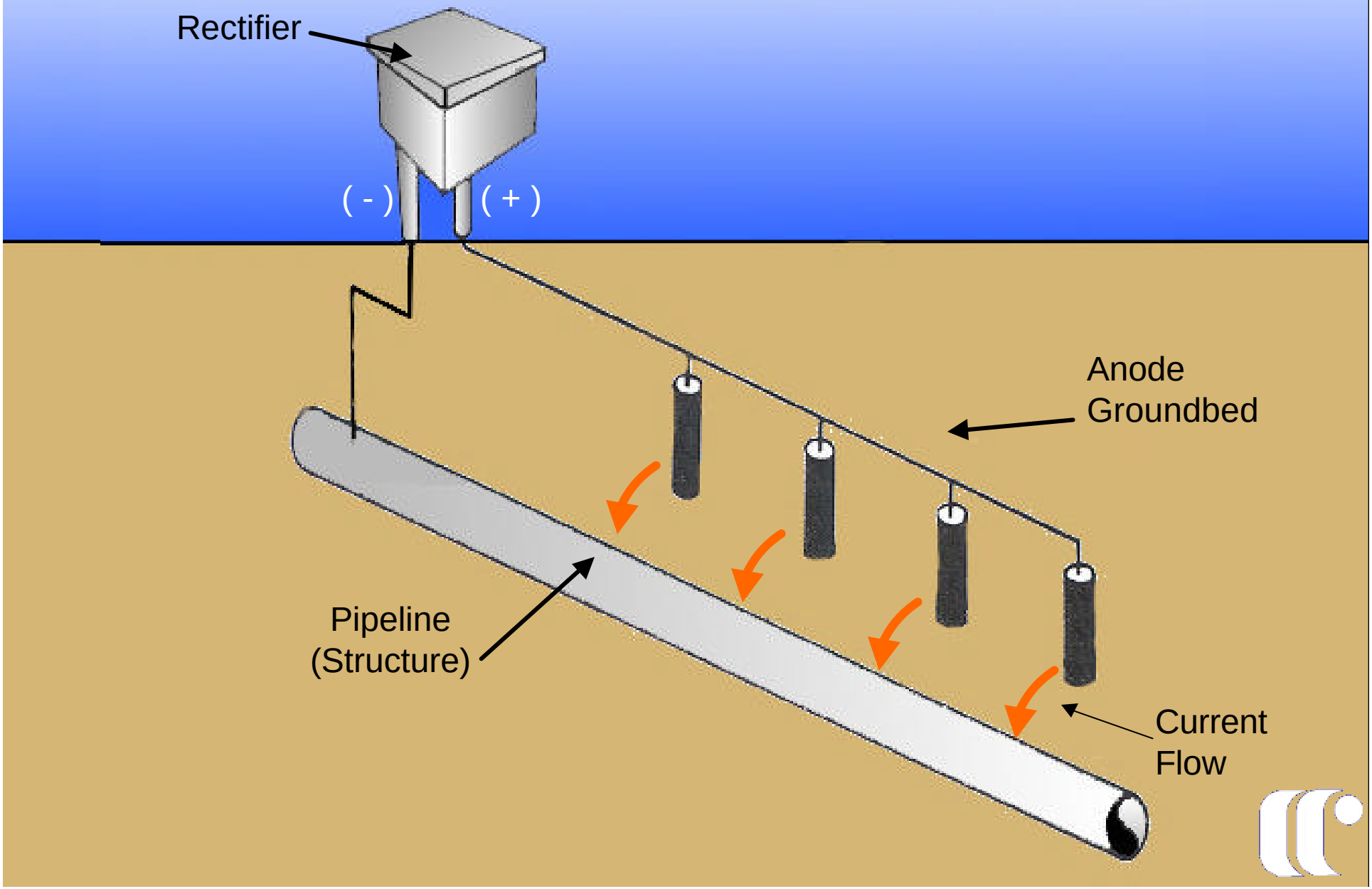
MARCO
CONTENTS
1-9# "CERTIFIED"
MARCO GALVOMAG
MAGNESIUM ANODE
MARCO ENGINEERING EXCELLENCE

Impressed Current Cathodic Protection System

- Anodes
- Rectifier
- Wiring

COARSE
FINE
RIS
ON
OFF
VOLTS
AMPS
STRUCTURE
ANODE

Impressed Current System



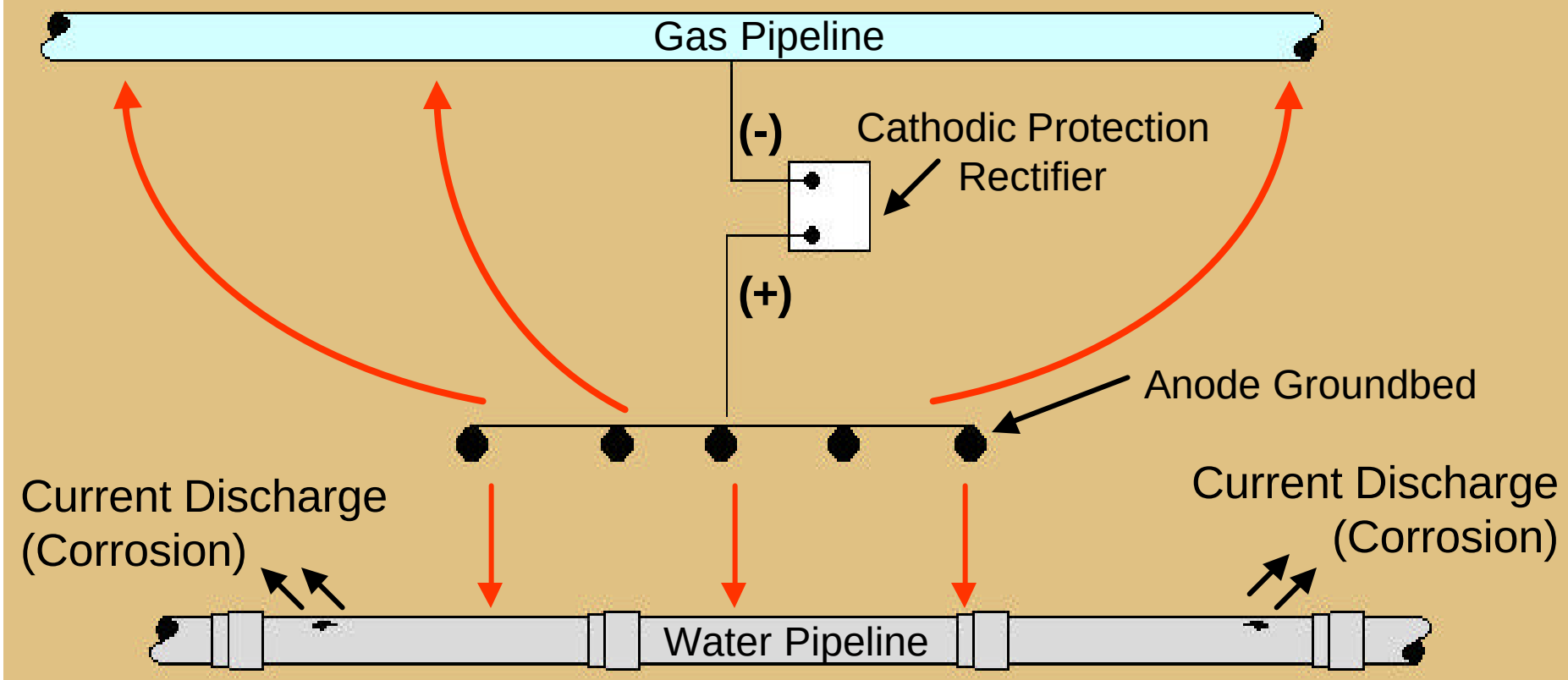
System Characteristics

Galvanic

- No external power
- Fixed driving voltage
- Limited current
- Small current requirements
- Used in lower resistivity environment
- Usually negligible interference

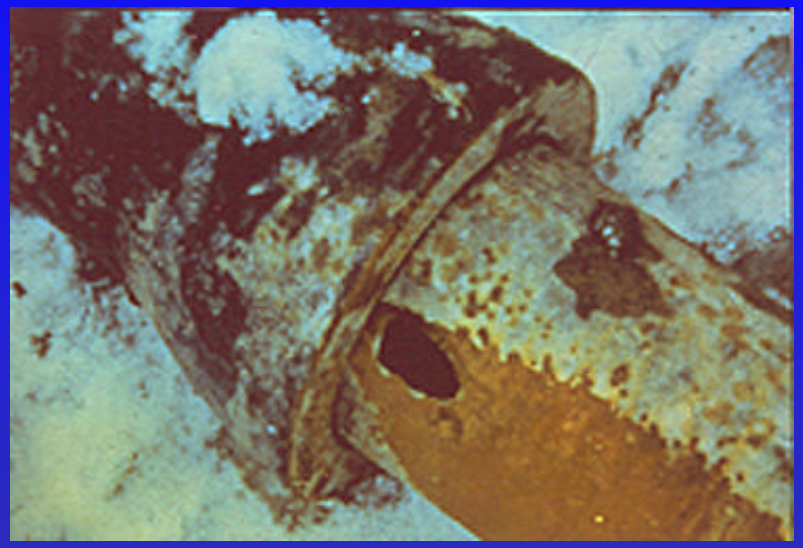
Impressed

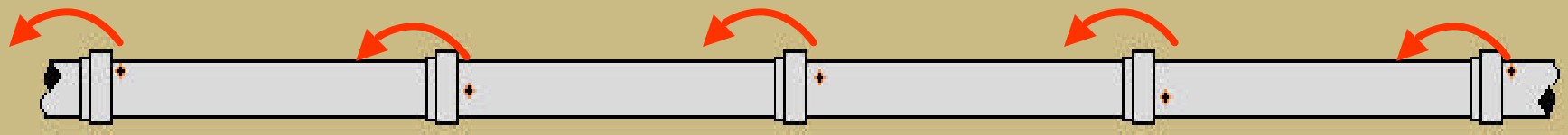
- External power required
- Voltage can be varied
- Current can be varied
- High current requirements
- Used in almost any resistivity environment
- Must consider interference with other structures



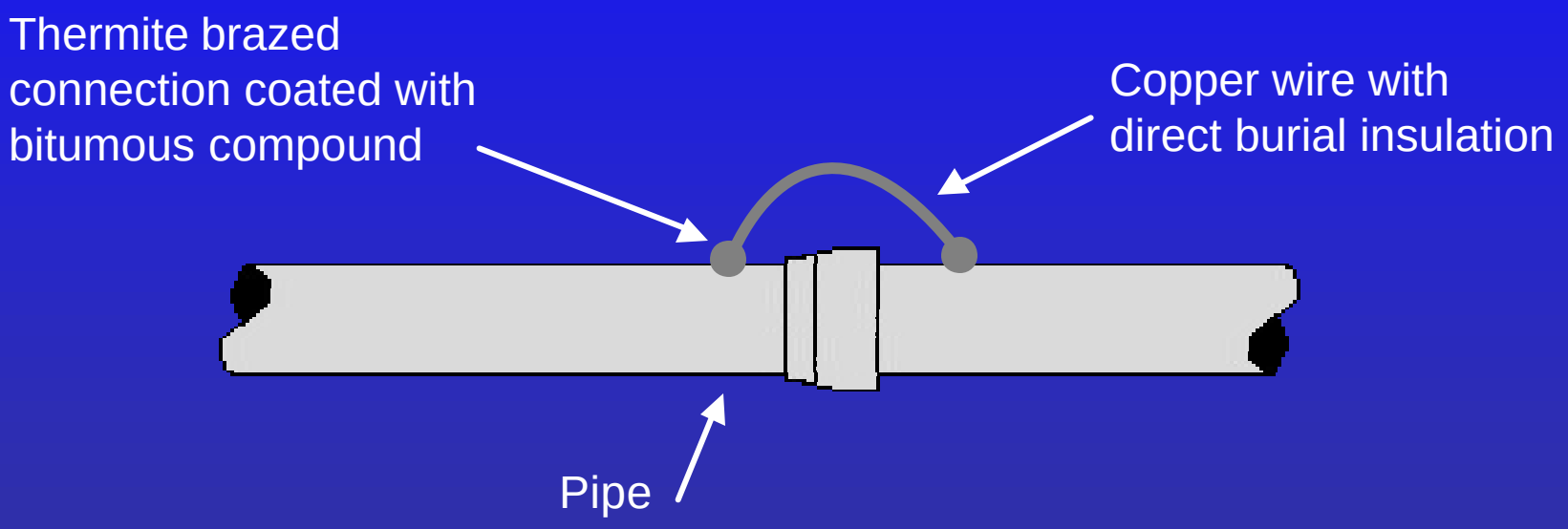
Stray Current Due to Impressed Current Cathodic Protection System

Stray Current



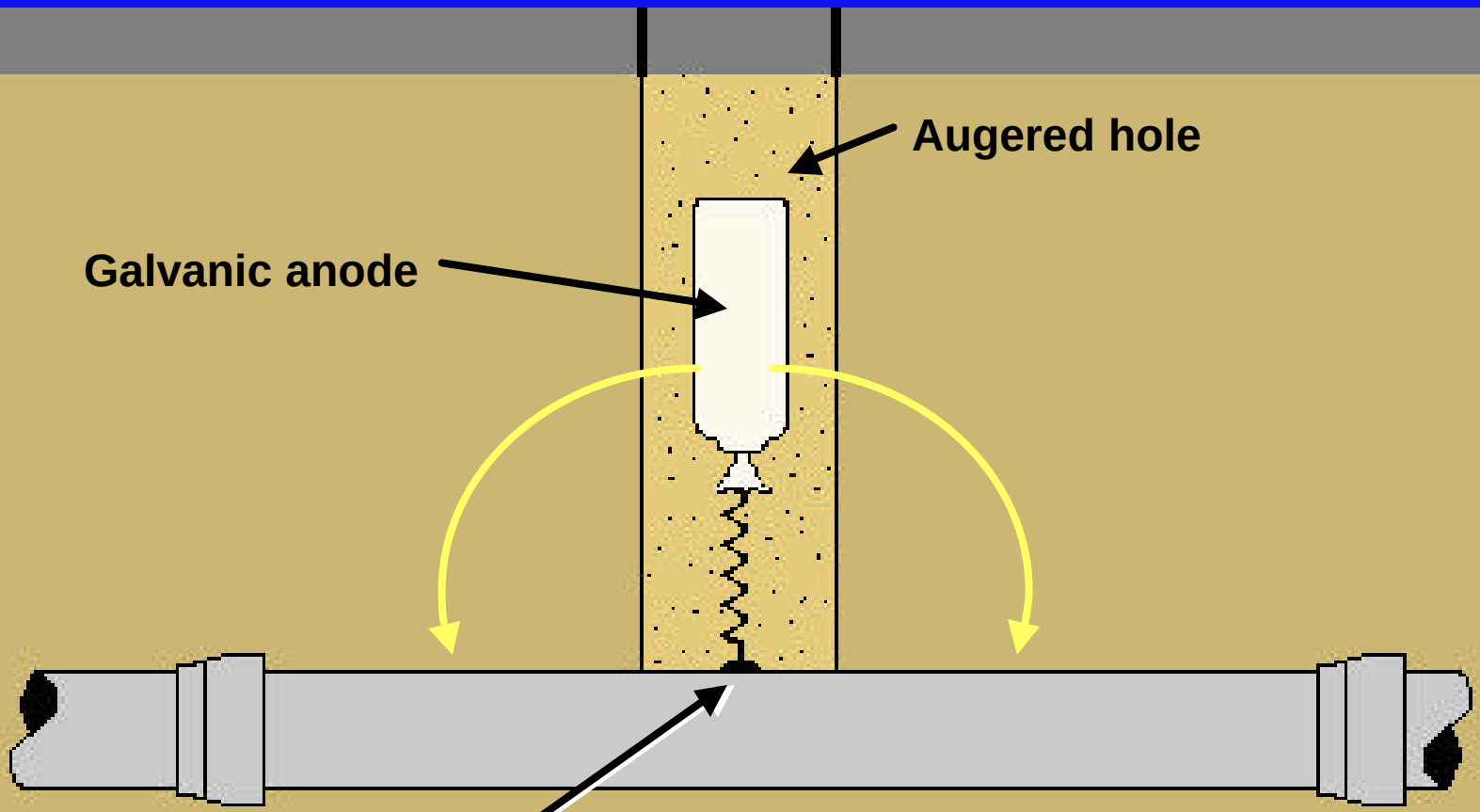


Bonding Across a Bell and Spigot or Slip-joint



<u>Corrosion</u> is the leading contributor to cast and ductile iron water system breaks!

Anode Installation



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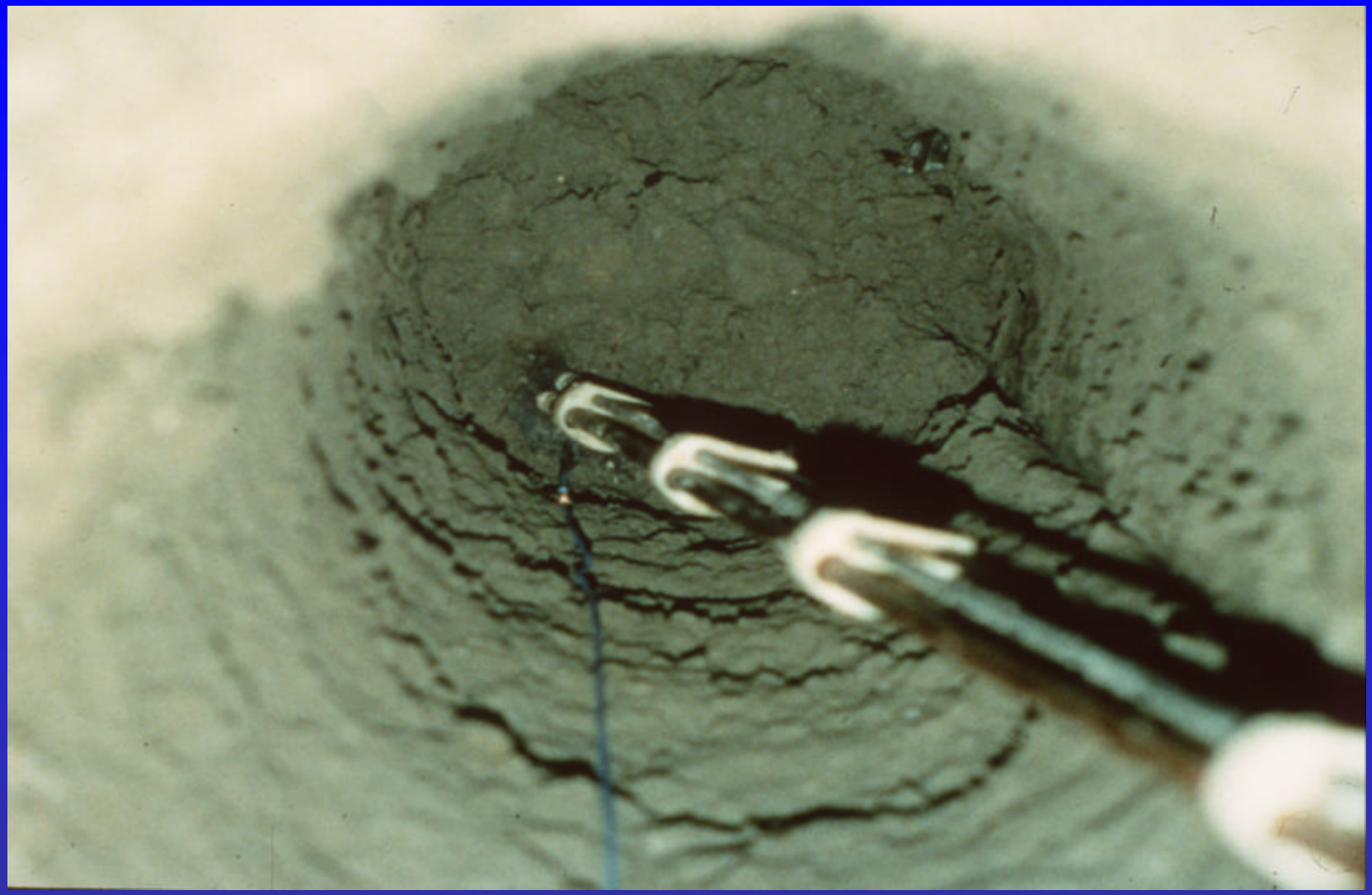
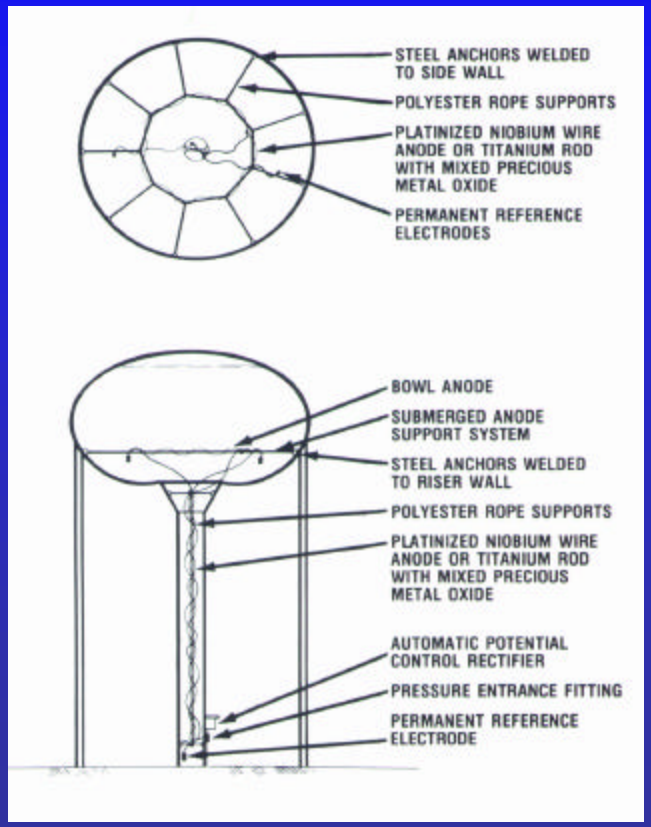


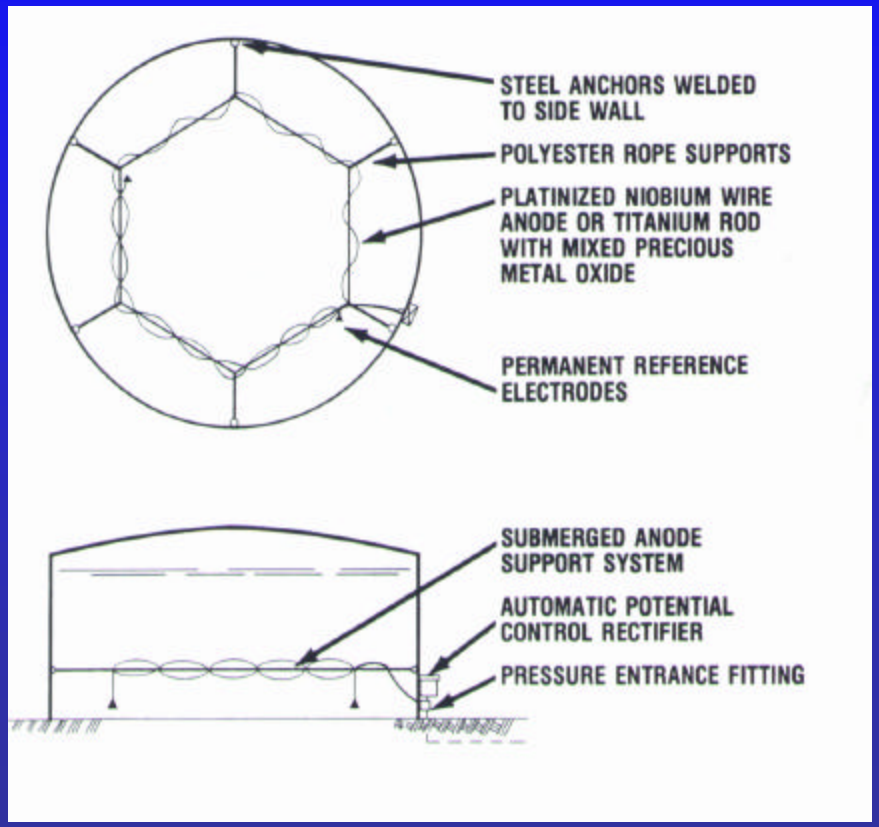
Anode lead wire connection to pipe using spot welder.

Water Storage Tanks and Treatment Facilities Possess the Four Requirements for Corrosion Cells to Form

- Electrolyte: Water and/or Wastewater
- Conductor: Steel Tank or Equipment
- Anode: Metal in contact with the electrolyte
- Cathode: Metal in contact with the electrolyte

Typical Horizontally Suspended Anode Systems





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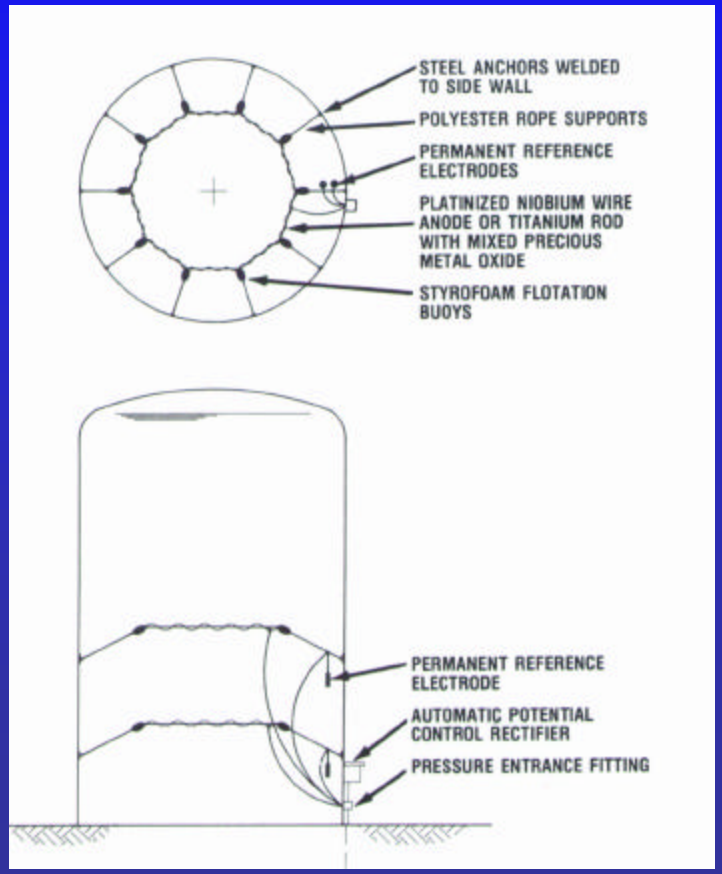
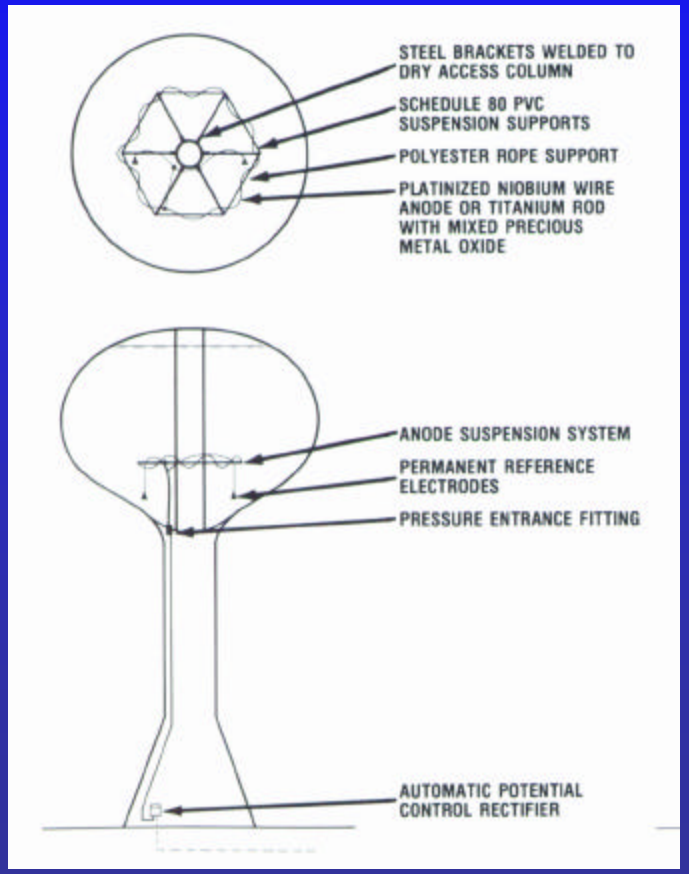
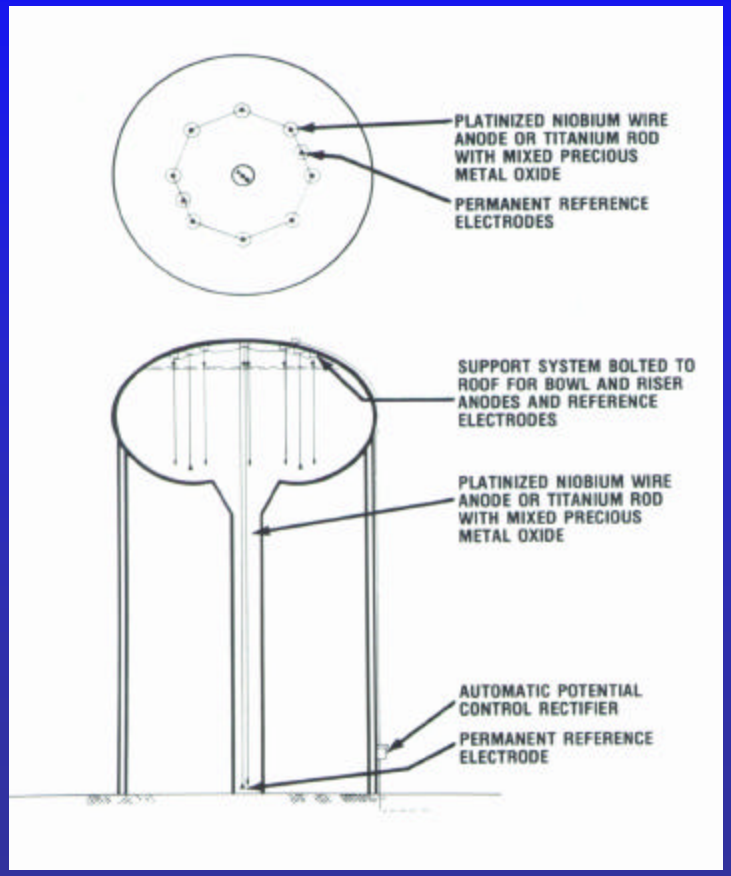
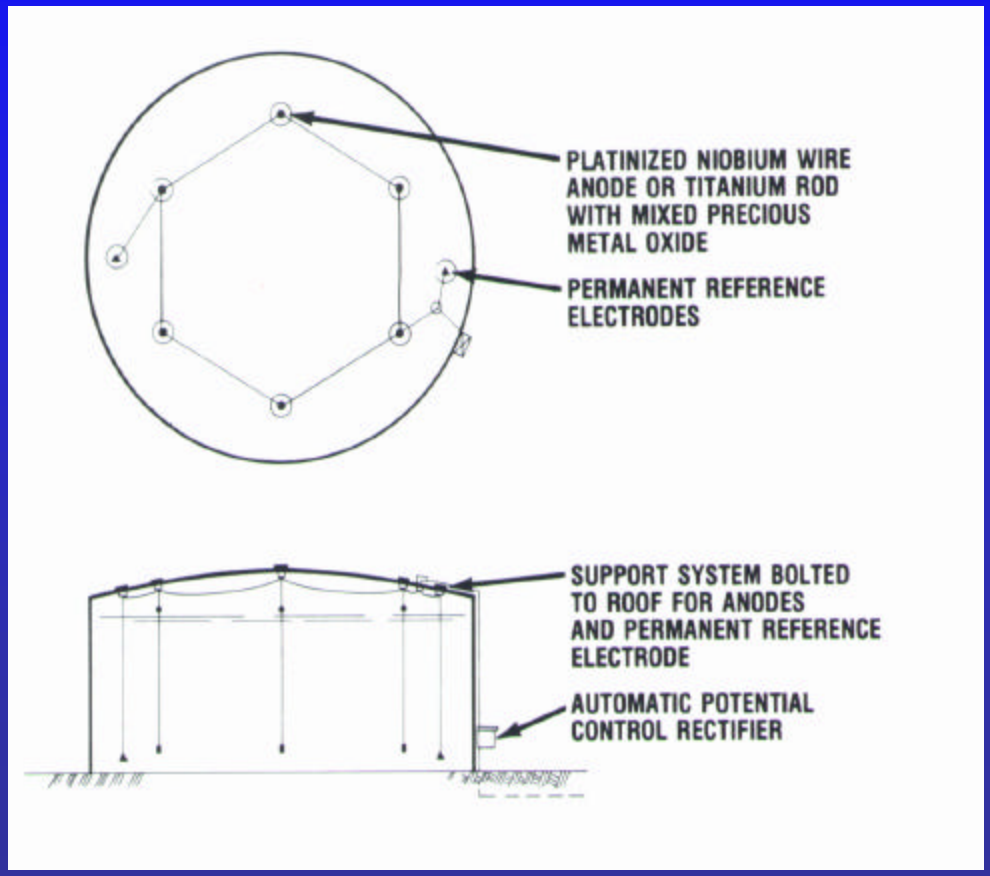




Typical Vertically Suspended Anode Systems





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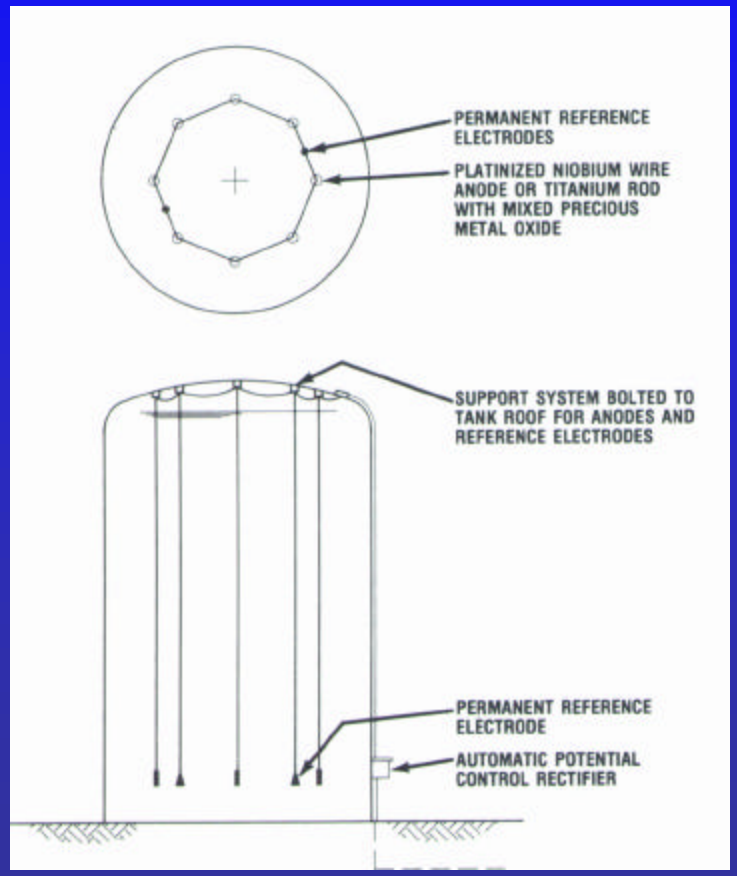

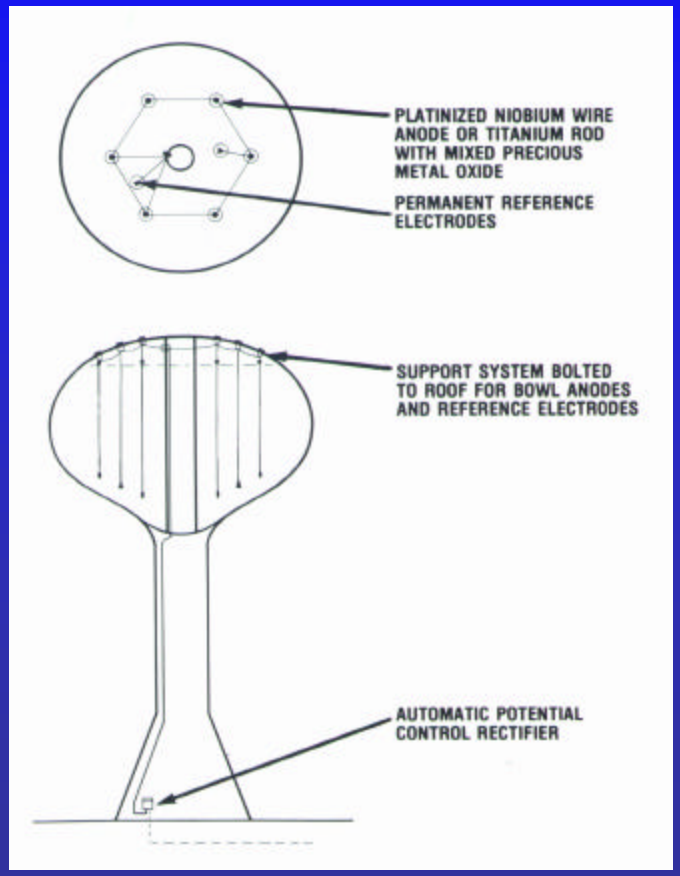

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